Form ESA-B4. Summary Report for ESA-151-2
Public Report - Final

Company	Kraft Foods Global Inc.	**ESA Dates**	August 7-9,2007
Plant	Mason City, IA	**ESA Type**	Compressed Air
Product	Individual pudding and gelatin snacks	**ESA Specialist**	Greg Wheeler

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
Kraft Foods Global Inc. in Mason City, Iowa, produces Jello refrigerated, ready-to-eat pudding and gelatin snacks, including fat-free pudding, sugar-based gelatins, sugar-free gelatins, cheesecake, and smoothies snacks.

Objective of ESA:
The objective of the ESA is to model your compressed air system using the AIRMaster+ software tool and to use the tool to identify savings from several measures that would improve system efficiency. It is not the objective of the ESA to look at all potential plant improvement opportunities. Kraft Foods Global Inc. has an objective to reduce energy use by 20-25% by 2011.(not sure if this should be in the report as it will go public.)

Focus of Assessment:
The focus of the ESA is for plant personnel to understand how the appropriate DOE tool can be effectively applied in the plant. The focus of this ESA is the main compressed air system.

The compressed air system includes 4 Ingersoll-Rand Centac centrifugal compressors: three (3) model C-25 600 hp compressors with inlet valve modulation and blow-off control, and one (1) model C-23 500 hp compressor with inlet guide vane and blow-off control. The system is controlled by an IR ASC control system. All four compressors operate year round to insure that air is available when equipment use swings require air.

Two compressors are located in each of two compressor rooms, connected to a common header. The compressors operate between 112 and 115 psig with two flow-pressure controllers that deliver 98 psig to the plant. The house compressor room has a PneumaTech model PSC-5000, 5000 cfm, twin tower, heat-of-compression regenerative desiccant dryer. The sterile air compressor room has a model PSC-6500 dryer. The dryers operate on a 4-hour cycle for each tower that includes normal drying for approximately 3 hours, then a 1 hour purge and cooling cycle. Then the towers switch function.

The air distribution system has three (3) 3800 gallon receivers and two (2) 2500 gallon receivers. There is approximately 650 feet of 10” and 8” header piping throughout the plant that adds an additional 310 cubic feet of storage capacity for a total storage capacity of approximately 2500 cf. The piping system is efficient with no apparent pressure loss or air storage problems.

Approach for ESA:
1. Identify and understand the compressed air system(s) and determine priorities for opportunities to pursue.
2. Identify critical airflows, pressures, end uses, temperatures and other information that will be required for the analysis.
3. Gather available data and trend logs and develop a list of data that needs to be obtained from other sources or that needs to be measured or logged.

4. Reduce and enter this data into the AIRMaster tool and check for internal consistency, such as with metered energy use. Data will be verified and adjusted, if necessary. Team members will enter data into the AIRMaster tool and check results for feasibility.
5. Acquire cost estimates from vendors if possible. Estimate range of improvement costs from previous plant and Qualified Specialist experience.
6. Demonstrate AIRMaster to interested participants.
7. Complete:
   - Plant Intake Questions
   - Summary Report
   - Software Tool Output
   - Evaluation

General Observations of Potential Opportunities:

- Indicate total plant natural gas cost for base year, 2006 (please obtain this if possible)
- Indicate total plant electrical cost for base year, 2006 (please obtain this if possible)
- Indicate impact fuel cost in $/MMBtu, impact electrical cost in cents/kWh if necessary for ESA
- Note what you would expect would be Near Term, Medium Term, Long Term opportunities. See definitions below:

  - Near term opportunities would include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
  - Medium term opportunities would require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
  - Long term opportunities would require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

- Estimate, if possible, the identified % plant fuel savings from a) Near Term opportunities; b) Medium Term opportunities, c) Long Term opportunities.
- Estimate, if possible, the identified % electricity savings from a) Near Term opportunities; b) Medium Term opportunities, c) Long Term opportunities.

Results.

The following results and recommendations represent the best information that we have at the time. The compressed air specialist believes that the results and estimated savings are reasonable, but strongly recommends getting more long-term operating data for plant compressors and confirming the compressor manufacturer's performance specifications before modifying the system based on these results.

Specifically, we were not able to export trend logs from your compressor control system and therefore were not able to make long-term average operating conditions, including variations and load swings. The compressed air specialist estimated average power, airflow, and inlet and bypass valve positions graphically from the control program for July 19 through 21, 2007, which appeared to be "typical" operating days.

Also, we entered into AirMaster the performance operating conditions (airflow and power) for plant compressors from the manufacturer's curves for the design pressure of 125 psig. The specifications were for inlet cfm (icfm) while the output ratings on the nameplates were in standard cfm (scfm). System airflow meters were also calibrated to scfm. Icfm includes internal compressor air uses, such as for control and losses and varies with manufacturer and compressor. We converted icfm to scfm by using the rated full load design conditions, taking the ratio of rated scfm to icfm, and applying that ratio to other operating conditions, such as surge airflow at rated pressure, max surge airflow, and maximum compressor airflow at the lowest pressure (choked condition). The compressed air specialist would prefer to see the manufacturers design specifications at plant operating pressure and in scfm, but we were unable to obtain such information prior to or during the ESA.

Finally, we entered the manufacturer's design operating conditions into AirMaster (bhp and icfm adjusted to scfm) and used AirMaster default calculations for operation at 115 psig.

1. Add Swing Compressor (savings 1.4% of plant electricity use, 5.4% of compressor use, Medium Term)

Situation: The existing centrifugal compressors with inlet valve modulation (3 C-25s) and inlet guide vane modulation (C-23) are inefficient at part loads, particularly when blowing off excess air. The goal is to base load the existing centrifugal compressors as needed and to add a swing compressor with high part load efficiency. Currently, the most efficient compressor at part load is the C-23, 500 hp compressor, because it has guide vane modulation. I modeled all compressors with the same full-load efficiency to not skew the results based on potential minor differences in individual compressor efficiency. The system currently has significant swings in air demand on the order of 2000 scfm, which is approximately the capacity of a 600 hp compressor. A centrifugal compressor with blow-off control has small variation in power (approximately20% from full load) regardless of air supply, and is therefore a poor selection as a swing compressor.

Solution: The compressed air specialist recommends considering the purchase of a swing compressor that is efficient at part loads and base loading the existing compressors at full load as needed. This could be a 2-stage, lubricant free compressor that operates in load/unload mode, has Variable Speed Drive (VSD), or a newer centrifugal compressor. Newer centrifugal compressors with inlet guide vanes have larger turn-down ratios, up to 50%. Airflow below 50% of capacity would be produced by unloading the compressor to approximately 20% of full load power until pressure drops and the compressor reloads. (Some compressors are designed to unload as a control strategy and others are not.) A centrifugal compressor might be easier to integrate with the existing control program.

Savings: AirMaster's first calculation is to meet airflow requirements with the same compressors in the same sequence as we entered for the base case. This mode results in operating existing compressors with 3 compressors base loaded and one compressor blowing off at approximately 30% capacity.

When we added a swing compressor and turned off one of the 600 hp compressors, savings come from operating the 500 hp swing compressor more efficiently at approximately 40% of capacity.

2. Reduce Air Leaks (savings 1.7% of plant electricity use, 6.7% of compressor use, Near Term)

Situation: Air leaks can be heard and felt at several locations in the plant. Andrew Engle found and tagged leaks using an ultra-sonic leak detector. Leak airflow was measured during a down day to be 1200 scfm.

Solution: Tag and repair air leaks. Fixing leaks is generally low cost in both time and materials, with paybacks typically less than one-year. Andrew estimated that air leaks could be reduced by 60%, or approximately 700 scfm

Savings: We assumed that the plant air system operates 8,448 hours/year (13 down days). These savings are possible with a swing compressor that uses less power with reduced airflow. There would be little or no savings from a compressor operating near 30% capacity in blow-off mode, since the result would be reduced blowoff, with little or no power savings.

The compressed air specialist estimated costs to reduce leaks by 60% to be approximately $25,000.

3. Improve End Use Efficiency (savings 7.1% of plant electricity use, 27.4% of compressor use, Long Term)

Situation: Compressing air is inefficient, losing approximately 90% of the power supplied as heat of compression. End uses in the plant that may be more efficiently managed with electric motors are diaphragm pumps and vacuum generators. A major end use is providing sterile air to the filling machines at slight positive pressure to prevent potentially contaminated air from the plant from contacting the product. Compressed air is supplied at a few psig with a resulting pressure in the tunnels in the range of an inch of water. Plant staff measured airflow of approximately 300 scfm per machine. Eight machines use this method for a total of 2,400 scfm.

Solution: The compressed air specialist recommends using one or more fans to supply low pressure air. A 75 hp fan should be in the right range, although the compressed air specialist recommends more careful measurements of airflow and pressure requirements before designing a fan system. Existing steam sterilization equipment should still be adequate. Current air filters capture particles greater than 0.02 microns but 0.01 micron filters are desirable.

Savings: AIRMaster calculates savings based on turning off another compressor. Plant personnel estimated the cost to include modifying equipment with shrouds, fans and filters.

4. Reduce System Pressure (savings 0.2% of plant electricity use, 0.8% of compressor use, Near Term)

Situation: The compressors operate between 112 and 115 psig. After filters and dryers, pressure is reduced to 98 psig for the plant. The plant has adequate air receivers and storage and good distribution piping with no significant pressure drops. Some equipment can operate at 60 psig, although the packaging machines use most of the air and require 90 psig.

Solution: The compressed air specialist recommends reducing the discharge pressure at the compressors initially by 5 psi, and more in smaller increments if there are no problems. If a problem arises, consider the cost of resolving the problem versus the savings from reducing pressure. For example, adding a secondary receiver near the end use to meet an intermittent load, closing a piping loop, or adding a dedicated or booster compressor to satisfy a critical or higher pressure load. It may also be possible to reduce the pressure supplied to the plant below the current 98 psig, which would allow further reduction in compressor pressure.

Savings: Savings from reducing system pressure 5 psi.

5. Reduce Run Time (savings 1.6% of plant electricity use, 6.2% of compressor use, Near Term)

Situation: After implementing the previous four Energy Efficiency Measures (EEMs) the House C-25 #5 South is running baseloaded and the Sterile C-25 #2 is running at 79% of capacity. The swing compressor is off based on the sequence order we selected initially.

Solution: Turn off the #2 compressor and allow the swing compressor to operate more efficiently at part load.

Savings: AIRMaster calculates savings based on the change to sequence order based on the reduced airflow.

Other Measures Considered:

1. Consider connecting adjacent piping headers to form loops in which air is supplied to end uses from two directions. This would likely reduce local problems caused by pressure fluctuations.
2. Consider replacing pneumatic pumps with electric pumps to save approximately 75% of the operating cost.
3. Consider replacing the venture-type vacuum generators with the house vacuum system.
4. Consider making necessary repairs to the Pneumatech desiccant dryers to enable them to operate on dew point control. Specifically each tower currently purges every 4 hours to further reduce adsorbed moisture and cool the resin bed. Since temperature and humidity vary significantly over the year, the purge cycle should also vary. The manufacturers representative suggested that a major reason the the energy-saving “demand” mode did not operate properly is because the dew point sensor should be calibrated at least annually. Also, there is some doubt as to whether additional purge is necessary with a heat of compression dryer. Cool-down, if necessary, could be accomplished by additional interstage cooling between the purging tower and the drying tower, either by additional water-cooled heat exchanger or an air-cooled radiator.
5. Consider a lower cost approach to improving system efficiency. Some systems control several or all centrifugal compressors in parallel, which means that they all modulate at the same time. Since your compressors are more efficient when modulating than when blowing off excess air, the goal is to keep all compressors modulating, none blowing off. If all compressors reach the bottom of their modulating range and begin to blow off excess, you might be able to turn off one compressor, allowing the others to operate near full load. However, this strategy would not be handle large pressure swings as well as a newer swing compressor.

Management Support and Comments:
Kraft Foods Global Inc. has an objective to reduce energy use by 20-25% by 2011.

DOE Contact at Plant/Company: (who DOE would contact for follow-up regarding progress in implementing ESA results…)